



HIPPOCRATES REVISITED

A Search for Meaning

Editor

ROGER J. BULGER, MD

Executive Officer

Institute of Medicine of the

National Academy of Sciences

Professor of Medicine

The George Washington University School of Medicine



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Chapter 16

Research:

The Promethean Dilemma

Joshua Lederberg, PhD, MD

It may be necessary to liberate technology and science and bring the institution of technology under more effective self-control, of the type exerted in medicine. Technology would then be collectively more responsible, while entrusting the detail of its work to the only community able to judge it well—itsself.

PERSONAL PREFACE

As far back as I can recall, the ethical and intellectual precept that has guided my life-work has been the use of reason in the service of man. We have few other distinctions; integument, claws, and fangs have all atrophied in favor of the instruments that brain and hand could devise.

The most urgent and rewarding service to men surely is provided by the healing arts. My own career has been spent on the fringes of medicine, mainly in basic biological research, but along lines with an eye toward some eventual utility in protecting health or in the succor of medicine. My role in this volume is perhaps somewhat that of an outsider. Certainly I am bound to express some disagreement with some of my colleagues' admonitions against a commitment to research instead of clinical care.

Editor's Note: Dr. Lederberg, a Nobel Laureate, is one of the world's foremost geneticists. In recent years his career has been characterized by an increasing involvement in the social and philosophic implications of science and technology.

This was a choice I had to face 25 years ago: either to complete my medical studies (at Columbia College of Physicians and Surgeons) or further pursue my research in bacterial genetics. I am sure there are temperamental issues that each individual must answer to his own satisfaction. One personality may require the immediate rewards of benefaction to an individual patient whose life is trusted to his care and judgment. Others may be impatient with the complexities of individual behavior that seem to interfere with efficient solutions to a disease problem. But this is more a matter of taste than moral imperative.

One can argue, as I am sure I must have done during my own adolescence, that Louis Pasteur as a medical investigator did incomparably more good for man than he ever could have done as a personal physician. But today the Pasteurs are forgotten, and science is taxed with such morally complicated discoveries as dynamite and nuclear fission. Certainly, efficiency must not be deified as the cardinal principle in the choice of a life style. On the other hand, the existing art of medicine still

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Feelings against research that are expressed by certain practitioners of medicine and MD aspirants may be directed at the abstract and seemingly remote developments in contemporary science because these developments appear to be so removed from immediate human application. Some of these feelings are perhaps motivated by a fear of success, a fear that is promoted by the ambiguity of many large-scale ventures in recent times. Is the abolition of malaria or of smallpox an unmitigated good if it is merely followed by a population explosion and the perpetuation of poverty and exposure to famine? Will the discovery of a "cure for cancer" add more to the overall quality of human life than a few more years of senile decrepitude? Surely some of the rhetorical zeal that is often voiced about bringing medicine to the people, as if it were an alternative to the discovery of new scientific advances in medicine, is motivated by a desire to escape from these difficult questions of large-scale social influence. Providing care to specific, distressed individuals, in a one-to-one relationship, is surely free of some of the doubts that attend global interventions. However, there is no easy escape from these dilemmas. The ideology of diffidence about research may be as Promethean an intervention as any creation of the laboratory.

In this essay, I will deal with some broader aspects of the attack on science and technology. Many questions have been raised to which there are no simple answers, and to which no answers will be found if we rely on accusatory polemics or defensive dogmatism.

TECHNOLOGY AS DIABOLISM

In *The Myth of the Machine—the Pentagon of Power*, Lewis Mumford traces the philosophical roots of the contemporary techno-cultural-ecological crisis back to Galileo and Copernicus. He alleges that the enthronement of the "sun god" at the center of the solar system led eventually to an objective cosmology and demeaned the values inherent in earth-centered man. The intuition of some purpose outside of man could justify political absolutism, religious tyranny, and the destruction of the earlier ecological values which are implied by the numerous earthly gods of primitive cultures. We can argue in turn that Mumford's complaints are directed as much to monotheism as to heliocentrism; within the framework of his discussion, the sixteenth- and seventeenth-century conflict between church and science was a passing sectarian squabble. Monotheism's axial role was to liberate human thinking from polytheism, or animism—the interpretation of the world and every process in it as the work of spirits, demoniacal or beneficent, fabricated essentially in man's image.

Today we no longer deify the sun, the planets, the oceans, or the volcanoes. The One God of the Judeo-Christian tradition is inseparable from a universe ruled by law.

Animism is still a convenient metaphor and shortcut to detailed analysis. It is convenient, at times, to regard a computer as if it were a quasi-intelligent being, responding to instructions and replying to inquiries like a willful child. The scientist can better design certain experiments if he visualizes a molecule as a perceptive organism, and thinks how it can "be aware of" the physical and chemical details of its local environment. The most literal acceptance of the Darwinian theory does not hinder the experienced biologist from speculating about the "purpose" of an organ, as shorthand for a description of its evolution under the shaping influence of utility tested by natural selection. These are nevertheless metaphors, consciously preserved, which clearly can

lead to error, folly, and disaster if they are misapplied outside the range of the appropriate analogy. We do not allow computers to vote, and we do not expect man to painlessly improve his genetic makeup merely by wishing for the good or needing to achieve it.

Many authors besides Mumford have tended to animize technology. Artful metaphors may be drawn, for example, the hypothesis that a technological society behaves as if technology were an autonomous malevolent force within it, that is, a devil. But this is a subject requiring careful definition and investigation and it is promptly obscured if the metaphor is taken for granted. The hypothesis can be made into a self-evident axiom by labeling the collective imperfections of society as "technology," as Theodore Roszak does in his book, *The Making of a Counter-Culture*. He attributes *Playboy's* derogation of meaningful sexual relationship to technocracy. Such a definition does not help very much to discover who is a "technologist."

WHO IS A TECHNOLOGIST? Among engineers and scientists, technology means the concrete application of scientific knowledge to problems of human significance. It also means the organizational structure, the body of experience, the operational hardware, and the people who design and man it, and the end product. By further extension, technology may also be taken to mean science itself (knowledge about the natural world) and the community of scientists. The term technology conjures images of computers, suspension bridges, freeways, factories, nylon, jet planes, telephones, nuclear bombs, auto exhausts, pacemakers, television, penicillin, and DDT. These are products that are unique to the technology of the present century. It should also include the abundance of our crops for food and fiber, fire, and the domestication of dogs and horses. It also means cheap paperback books, a progressive relief of the burden of labor, and a standard of living whereby youth can spend 20 years getting an education, rather than go to the field or factory at 12. It is in fact the whole texture of modern life, based on the

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Insofar as technology is the indispensable instrument of social action, the most conspicuous faults in modern life are (by definition) the *misapplications* of technology. We have still to analyze the sources of that misdirection, for technology is a tool in the hands of men. This is neither to deny nor affirm the diabolical hypothesis that such a misdirection is inevitable, given the power of technology to amplify discrepancies of wealth and opportunity or the ideological impact of scientific skepticism on the shaping of human goals and aspirations. Nor can we give perfect marks to scientists and technologists for doing all that they might do to apply their special insights *about*, as well as *of*, science and technology for human welfare.

Do we, strictly speaking, live in a "technocratic society," if that implies that the major decisions are made by a scientifically trained elite?

There is much evidence to the contrary! It was one of our most respected Presidents who, against the advice and urging of many physicists, decided to end the war against Japan in 1945 by dropping the A-bombs on Hiroshima and Nagasaki (a complicated decision that is easy to criticize in hindsight). Indeed, it would be an intolerable arrogation of authority if scientists were to make such decisions against the informed conclusions of politically responsible leaders in a democracy. In recent months, scientists have been vehement in their denunciations of the SST and the ABM, and have been in the forefront of many other campaigns for restoring the quality of the environment. In the Soviet Union, they are the one irre-

ducible focus of liberal thought, breaching national barriers to join the only effective world community functioning today.

The antitechnologist can, of course, find many texts to support his condemnations. The architect Albert Speer is much quoted for his remark that "some day the nations of the world may be dominated by technology—that nightmare was very nearly made a reality under Hitler's authoritarian system." But if we look more closely at this meaning, we find he refers above all to the radio and the telephone, systems by which a central authority could readily diffuse its commands without requiring the personal presence of the dictator. In fact, the Hitlerian regime did its utmost (and in many fields succeeded) to eradicate free scientific inquiry, and allowed only work judged relevant to the superiority of the German race to flourish. The technicians whom Speer describes as blindly following orders were simply bureaucrats. And, as Speer also documents, Hitler lost his bid for a millennial Reich in large measure because of the contradiction between objective scientific analysis and the central mystique of the German soil and race.

We could still profitably pursue parallel investigations that would help us to illuminate the sources of technopathy (the pathology of science and technology). Consider how many of the world's ills are attributable to language or to law out of control!

Language is, of course, the instrument of every deception and manipulation, as well as of man's utmost achievements. It is the means of reason and poetry alike, and confines them both. Should we not offer the same complaints against language that we do against technology? After all, language is the fundamental technique of the human species, which makes all others both possible and inevitable, through the process of culture. And could we not make a parallel argument about law—that it liberates and enslaves man at the same time?

These analogies have too much substance to be dismissed, but even apart from the obscene confusion of technician and technocrat, a

valid indictment emerges not in spite of, but as a consequence of, the exoneration of technology. Technology, like law and language, is an institution whose realization depends on a particular community. Language comes closest to being a product of the whole community, and we share a collective burden for its advance and misuse; we do not confuse the linguists who merely study language with the whole culture that invents and enriches it. Law, at the other extreme, is shaped by a body of men—the legislators, lawyers, and judges—who are professedly responsible to the culture for its defects as well as its virtues. The law, like other organized professions, is also ruled by its own code. This is far from perfect, but it still serves as a specific nexus of confrontation with the culture's demands and an indispensable protection to the morale and efficacy of its individual members.

A definite though less tangible standard binds the behavior of the basic scientist who is dedicated to the exhibition of publicly verifiable discoveries. The technologist, however, sells his services to the highest bidder—producing whatever design a customer has the means to support. (The physician likewise does not judge the social virtues of his patient. Does this entail a moral copout?) He thereby transfers responsibility onto other shoulders, and in this particular sense the technologist (as distinct from a scientist) is a mere technician serving another master. This elusive irresponsibility of the technologist, in the face of the enormous amplification of power his work conveys, may be the ultimate exasperation that fuels the aquarian crusade. In one sense, technology is too ill-defined to be a legitimate target; in a deeper one, this is precisely the problem, given the disturbance it undeniably intrudes into the complacency and placidity of life. Science is somewhat better organized as a community, but suffers from the same vacuum of responsibility for the technical elaboration of discovery.

HOW TO CONTROL TECHNOLOGY It has been suggested that technology, and by extension

science, should be brought under more explicit social control. The real need may be to liberate it, that is, to bring the institution of technology under more effective self-control, of the type exerted in medicine. Technology would then be collectively more responsible, while entrusting the detail of its work to the only community able to judge it well—itsself.

Carried to a logical extreme, this would paralyze government and industry—if we mean that every technically trained employee in large organizations has the right and responsibility to judge every consequence of his efforts, and to sabotage whatever he deprecates. Furthermore, it goes beyond human reason to know the full outcome of any technological innovation. Shall we indict Alexander Graham Bell for the telephone that made Hitlerian totalitarianism possible? Shall we indict Mueller for DDT? And if so, should it be because of damage to wildlife, or rather because the effective control of malaria accelerated the population explosion? Would fewer lives have been ground up in war since August 1945 had the airplane or the atomic bomb not been developed? Or more? And what about the future?

There are, nevertheless, two major forms of socially useful control that a well-organized profession of technologists would advocate and could enforce.

First, major technological projects could be subject to disinterested review and licensure, to be certain that the intended profits in one area of the economy are not simply stolen, covertly, from another. This is the much discussed function of technological assessment. It deals with such questions as the true cost of the SST or of electric power, taking full account of the threatened impairment of the environment. It can equally be concerned with the full costs of technological displacement or monotonization of labor, invasion of privacy, or threats to any of the other cherished values of life. Almost all of the tangible grievances against technology can be covered by the extension of our economic system to take broader account of the values that make life worth-

while. It is furthermore within the power of a democratic society to insist on this—and scientists and technologists are just beginning to exercise their responsibility for systematic efforts to press public policy in this direction. The technology assessment need not all be delegated to a central authority, for regulatory agencies often ossify after their first flurry of reform. Alternatively, we should consider chartering pluralistic consumer and environmentalist organizations to allow them a standing in court as representatives of large groups with grievances that cannot be pursued on behalf of any one individual. There is already considerable momentum today by groups for conservation law and for consumer class actions to make equitable law in the courts. They would be greatly helped, however, if they had a firmer legal standing to match that of the corporations and the labor unions. If such groups could recover compensatory and penalty damages on behalf of their extended constituencies, entrepreneurship bolstering the interests of the consumer and inhabitant would be encouraged, balancing the entrepreneurship so effectively mobilized for the producer, distributor, and extractor.

Developing effective technology assessment would, furthermore, dilute any need to "control" technological innovation at its scientific roots, a step which is both impractical and tyrannical in its implications.

Second, since technology assessment can only be applied where the costs can be anticipated, much research is needed at earlier stages of development to look for unforeseen troubles and to develop antidotes. Technologists could insist that every project be taxed to support critical investigations of its consequences. (This need not imply any privilege in the specific control of the direction of technological changes, which is best left as a primary function of the market economy and of government support and regulation.) Without the same kind of expertise that produced DDT or high-energy fuels, we would not have known that DDT has deeper ecological effects than wiping out insect pests, or that Los An-

geles smog is a consequence of unburned fuel in auto exhausts (rather than industrial pollution as would have been supposed by the naive observer). Technology has generated the environmental crisis, but science has discovered it, and is indispensable for planning the rational remedies. The closer some of this countertechnology can be placed in time, place, and motivation to the original sources of trouble, the more efficiently the latter can be neutralized.

To be sure, there are equally insidious social and economic roots to the environmental-technological crisis, and these may not be rectified without readjustments in the distribution of wealth and in our ideology about the meaning of human life and work. However, political solutions to these problems will be accelerated if we can expose and document the social costs of particular technologies. There is nothing in the ethic of science to oppose the reequilibration of values, and there is a great deal in its technique to help support it (and the technologists will work even more happily for consensual goals than for narrow ones). The trouble is that the consensual judgment does not always coincide with the most advanced insight—for example, on costs and pleasures of smoking cigarettes, allowing handguns to be freely available, investing in recreational lands versus strategic defenses, building freeways and dams, or making wars. The technologist is then caught in the middle, the most exposed target in the crossfire of social conflict. The university has been the chosen battleground partly as a by-product of its role as the seat of skeptical inquiry and to a lesser degree because of misconceptions about the potency of academic opinion on national policy. But this is the game of liberals. Radicalism sees the university as a place where bewildered and resentful youths, with unformed ideologies, can most efficiently be recruited as shock troops of revolution with expert assistance from indiscriminate doses of law and order.

As for the process of countertechnological inquiry, there are many kinds of incentives,

taxes, and penalties that could encourage this kind of harmony, but none of them will be implemented if the technologists themselves do not respond to a *crise-de-conscience* and demand it. At the very least, professional groups could accredit and rate technological organizations in accordance with their acceptance of this responsibility, and government contracting and tax policy could take account of the ratings. Needless to say, the federal establishment itself requires the closest attention. It is idiocy that radiobiological research within the AEC should have been cut back, as it has been, at a time of increasing commitment to nuclear power development and militant, if highly controversial, complaints about the reliability of standards of public exposure to radiation.

What of the basic scientist, the investigator who seeks "the truth for its own sake," though sharing the well-placed confidence that it will fit somehow into the machinery of technological power?

Modern science was founded as a response to questions of everyday life—the motions of the stars, the forces of gravity and of magnetism, the continuity and evolution of life, the composition of familiar matter. It promptly dispelled the remaining relics of animism and did a great deal to shatter faith in revealed religion, insofar as these misguidedly justified themselves by assertions of a scientific nature. Well into the nineteenth century, science could be regarded as a liberating or counter-religion, wiping away many naive superstitions.

My own education, in the early 1930s, was still colored by this function of science as a general world outlook; but science was already hopelessly fragmented into innumerable specialties, in very poor communication with one another. By that time, a man who wished to understand nature could function far more efficiently by learning more of what was already known than by attempting to carve new facts and interpretations out of the unknown. The process today has reached the point where very few scientific reports tell of insights that can have any significance to the layman.

Apart from the jargon in which they are phrased, he would have to know more than he cares to about the background before he could understand why a particular fragment would interest the specialist.

The contemporary work of science is thus hard to justify in terms of individual man's "need to know." Yet the body of scientific knowledge would be a sterile scholasticism if it were not constantly challenged and restructured. Merely to resolve the many inconsistencies it still contains would require constant resort to new tests. No two men can learn quite the same material; except for rote parroting learning is thinking and questioning and speculating. Without the criterion of experimental verification, accumulated learning would again become dry rot (as has happened at times in the past). It is fortunate, then, that the thrill of *discovery*, as much as learning, motivates the researcher. Nor can we ignore the motives of competition for prestige and for material rewards that help label scientists as human.

It is still true that contemporary science, in its fragmentation, tends to become more remote from the basic questions about nature that were its original invigoration. The effective practice of a particular science requires an extraordinary narrowness of focus, and rare indeed is the man whose inherent abilities and training leave any room for broader education or philosophical and social wisdom commensurate with the pervasive impact of science on the human condition. The historical pattern for the use of talent has been too fruitful to warrant being disturbed, but everywhere the need is also seen for another kind of scholar: the contemporary humanist, who can understand science in its original terms without being engulfed by the detail of one speciality; the man who, to use a now banal phrase, can also bridge the two cultures. The social need for this kind of intercultural moderator has not carved out any evident niches in the prestige and career structure of the academy, perhaps because there is no easy way to measure the quality of his perform-

ance, to select the good from the bad, as we pretend to do in the established studies. We may then stumble along with the help of those stragglers who have dropped out of the race of strict science, especially elder scholars—although age is confused with wisdom at peril.

This gap does manifest harm to the understanding of science by scientists themselves, as well as by nonprofessionals and those in the corridors of political power. Even the methodology of science is impeded, for we still await a more rigorous formulation of the process of scientific thinking that is itself needed to do science scientifically; that is, in a way that would give us the full use of computer technology. With rare exceptions scientists are remarkably naive about the logical foundations of experiments and verification, and imprecise in their linguistics. The scientific specialist usually has rather naive ideas about the process of science in the large and is too enmeshed in detail to see it in a broad philosophical perspective. The challenge has been left to another discipline (the philosophy of science) which has remained so isolated from laboratory workers that, for example, few students majoring in a given science will have been exposed to it.

The prestige of the "scientific method," nevertheless, has peaked to the point where it is often invoked, almost mechanically, for areas whose complexity and inaccessibility to controlled experiment demand equal respect for other kinds of insight and analysis. Science itself is just such a process, and to speak of "a science of science" may be justifiable only insofar as one would define politics and history as science. The arrogance of occasional claims that the scientific method can be used to prove some particular value system, including the assignment of a value to the pursuit of science itself, has certainly added to the embarrassment of science as an institution. Science has also been criticized for being "value free." But it is only from men, not their instruments, that we can legitimately demand a commitment to values.

We still have a proletariat and we still have

poverty in the US, but they are shrinking rapidly in absolute terms. Science and technology can do little to furnish a sense of the purpose of life to accompany material affluence, except for the elite few who can find it in the actual processes of inquiry and invention. It is only by contrast with the possible future, not with historical reality, that technological culture also fails in terms of the objective quality of life.

Faced with the task of clearing the residue of superstitious rubble in the nineteenth century, science may have preempted the task of religious reconstruction. But it can function only as critic, and then mainly for the internal consistency of a rebuilt faith. I do not advocate science as a basis of religious commit-

ment; but with all their faults, I know many scientists who are fulfilled. There is at least no inconsistency between the practice of science and leading the good life. Where scientists have rarely succeeded is in understanding themselves well enough to make their ethical and religious commitments a worthwhile source of leadership for many others, especially among the young. Many of their pronouncements and self-reports need insightful translation. What may have been left to isolated discovery by a pioneering generation must now somehow be built into the education of the next one—in order that the new generation be better equipped to make its own creative inventions.